Pedobiologia, Bd. 10, S. 401–406 (1970)

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Experimental observations on the rôle of *Glomeris* spp. (Myriapoda Diplopoda) in the process of humification of litter

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With one Figure

(Accepted 9. 1. 1970)

0. Introduction

The rôle of *Glomeris* spp. in the process of breakdown of litter has long been known and has been the object of a number of researches. FRANZ and LEITENBERGER (1948) found that the C/N ratio of faeces is smaller than that of the leaves on which *Glomeris* spp. have been fed, so that a degree of humification of organic substance is already achieved during the passage of food through the intestine of these arthropods. VAN DER DRIFT (1951) however believes that the transformation of food is not due to *Glomeris*, but to microorganisms which attack the leaves before they are eaten by *Glomeris* spp., or the faeces after they have been eliminated by the animals. More recently, BOCOCK (1963) found an increase in the amount of nitrogen in the droppings compared with the amount in the food [see also discussion on the argument in GERE (1956)].

I have attempted to re-examine the problem working with some species used by previous authors and with and endemic of Italy, *Glomeris euganeorum*; I have used in my experiments also a vegetal species, the holm-oak or *Quercus ilex* L., which had never been used before in these researches. Together with the rôle of *Glomeris* in the transformation of the C/N ratio, I have also tested the food preferences of animals of this genus of diplopods.

To this aim, food preferences have been tested by offering to the *Glomeris* simultaneously two kinds of leaves, and examining statistically the differences in the amount of the food taken by the animals.

1. The humification of the litter

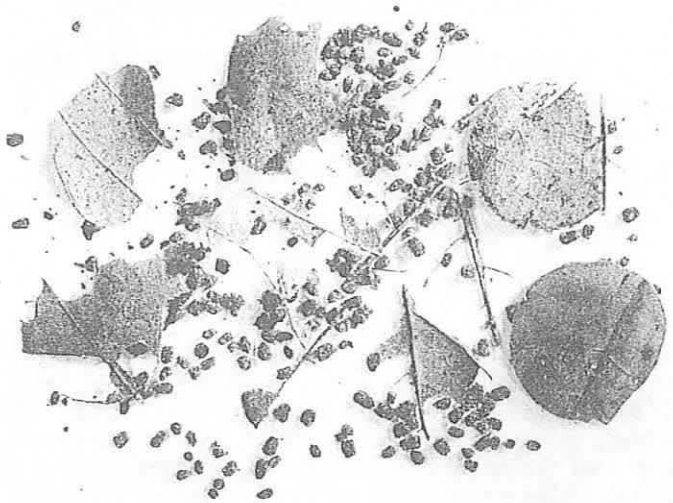
In the study of the humification of the litter we have determined the amount of carbon and nitrogen of leaves and of feaces, in order to calculate the C/N ratio. The determination of carbon has been carried out in the Institute of Pharmaceutic chemistry of this University[1]; the nitrogen has been determined with the method of Micro-Kjeldahl (PARNAS WAGNER), modified by PREGL[2]). The species of *Glomeris* used in this work are *G. euganeorum*, coming from the Colli Euganei (Padova), *G. undulata* (KOCH) and *G. conspersea* KOCH, both coming from the Venetian Prelaps (Monte Grappa). The leaves used are: oak, beech, chestnut and holm-oak. Before each experiment the animals were kept fasting for a period of 24 hours, in order to have all the faeces formed with the precedent food removed from the animals. The *Glomeris* have been fed on dry leaves[3]). The

1) I thank very much Prof. Dr. PIETROGRANDE who has done materially the determination and has given useful advice for the sampling of the material on which the analysis has been carried out.

2) These determinations as well as all the experimental part of the research, have been made by Dr. GABRIELLA FREDDO as part of her thesis work. The determinations of nitrogen have been carried out in the Institute of Biochemistry of this University; I am very much indebted to Prof. Dr. DAGMAR SILIPRANDI for her valuable help in this work.

3) The desiccation has been performed on P_2O_5 at room temperature.

faeces collected for the determination of the C/N ratio were desiccated at 105 °C, also to prevent a decomposition due to the action of microorganisms and a consequent variation of the original C/N ratio. The same process has been adopted for the leaves in which the determination of C/N had to be determined. Each analysis has been done in duplicate and the average has been then calculated.



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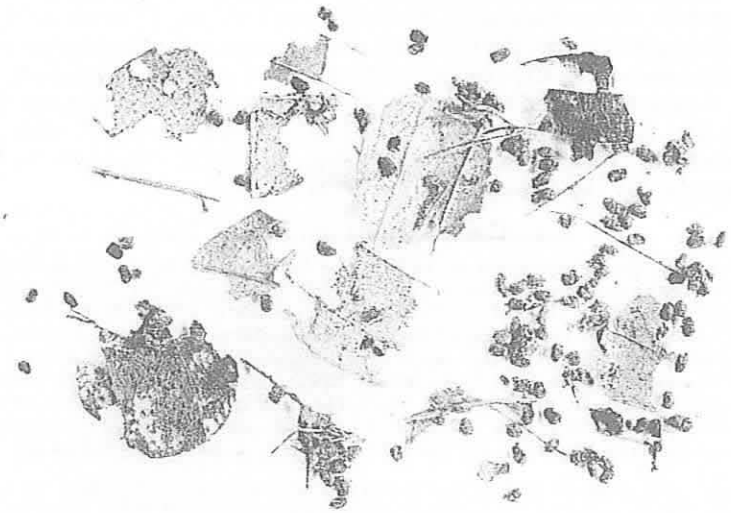

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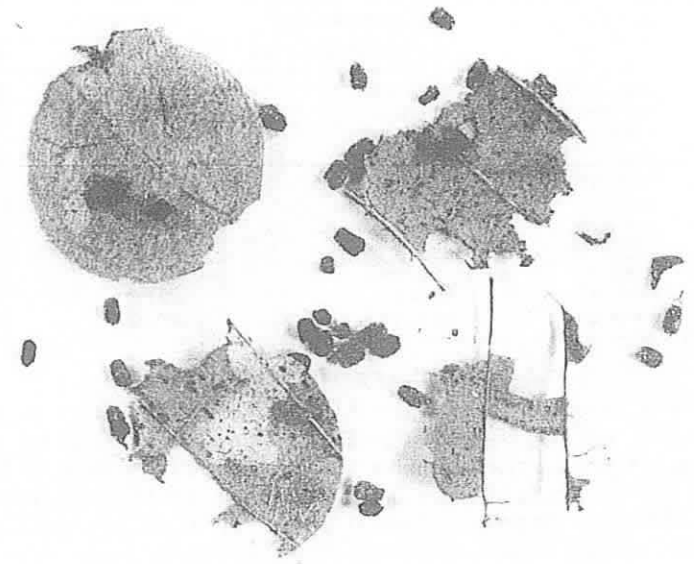

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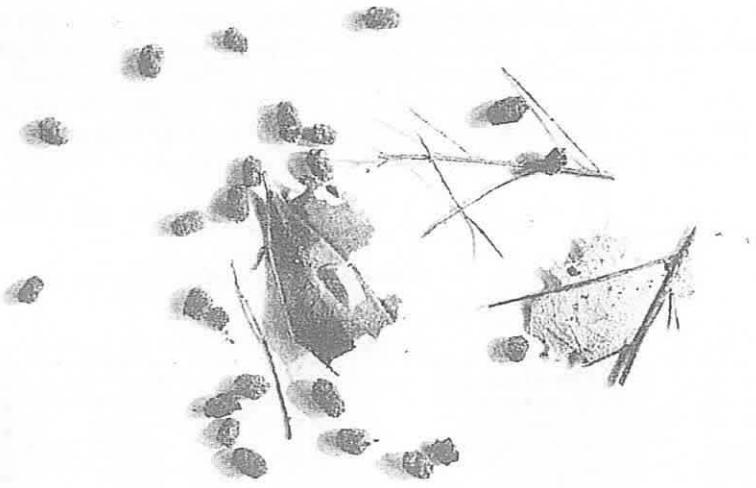

1d

Figure 1. Eaten leaves and droppings of: (a) *Glomeris undulata*, helm oak, (b) *Glomeris conspersa*, chestnut, (c) *Glomeris euganeorum*, chestnut, (d) *Glomeris euganeorum*, beech.

We may deduce from this that *Glomeris euganeorum* carries out a humification of all kind of litter, but more efficiently for chestnut leaves; the same holds for *G. undulata*, which is more active on oak leaves, and for *G. conspersa*, which is particularly active on holm-oak leaves.

The following are the results of the analysis:

Species	leaf on which the species has been fed	C/N ratio of leaves	C/N ratio of faeces
euganeorum	chestnut	31,44	20,25
euganeorum	beech	28,00	25,56
euganeorum	holm-oak	31,86	27,95
euganeorum	oak	36,32	27,30
undulata	chestnut	34,48	27,55
undulata	beech	30,50	26,80
undulata	holm-oak	32,10	26,90
undulata	oak	39,10	29,50
conspersa	chestnut	29,82	26,31
conspersa	beech	29,86	27,20
conspersa	holm-oak	38,79	25,61

2. Alimentary preferences of *Glomeris*

The species tested are *G. euganeorum* (from the Colli Euganei), *G. undulata* (from Monte Grappa) and *G. pulchra*, (from middle Dalmatia and southern Dalmatia). For each species of leaf some circular pieces were cut and left in a jar at R. H. of 100% for about 2—3 days in order to establish an equilibrium between the leaf and the environment. The pieces of leaves were then weighed rapidly in order to minimise the loss of water due to the lower humidity of the environment. The animals were kept at high humidity and fasting in order to facilitate their attack on the leaves to be tested. Three or four animals were then put in a receptacle kept at high humidity, with two disks of leaves of different kind. The experiments were carried out at room temperature. For each couple of leaves 4 tests have been generally made. At the end of the experiment the remains of the leaves (Fig. 1) were taken up and weighed in order to find the amount of leaf eaten by the animals. This was calculated as the difference between the initial weight and the final one. Another experiment was carried out, in which the surface instead of the weight of leaves, was determined.[4]) This was achieved by putting the leaves on millimetre paper and drawing their contour. By measuring the surface of the leaves at the end of the experiment the amount of food taken by the *Glomeris* was easily determined.

To the results thus obtained the "t"-test has been applied in order to test the significance. The following are the results:

species	leaves between which the comparison has been made	t	P(%)	significance	preference
euganeorum	holm oak-chestnut	3,00	5—1	scarce	holm-oak
euganeorum	chestnut-bramble	10,00	0,1	high	bramble
euganeorum	oak-chestnut	1,90	> 5,0	absent	none
euganeorum	oak-holm oak	1,70	> 5,0	absent	none
euganeorum	chestnut-beech	1,20	> 5,0	absent	none
euganeorum	beech-oak	0,70	> 5,0	absent	none
euganeorum	beech-holm oak	2,70	5—1	scarce	beech
undulata	holm oak-chestnut	2,20	> 5,0	absent	none
undulata	beech-chestnut	0,48	> 5,0	absent	none
undulata	oak-holm oak	2,70	5—1	scarce	oak
pulchra (from middle Dalmatia)	Cistus-Pistacia	1,09	> 5,0	absent	none
pulchra (from southern Dalmatia)	Cistus-Pistacia	1,30	> 5,0	absent	none

4) Also Döllng (1962) weighs and measures the leaves attacked by aquatic primary degraders.

We may deduce from this that *Glomeris euganeorum* shows a true preference only for bramble when tested against chestnut; secondarily it prefers holm oak to chestnut and beech to holm oak; *Glomeris undulata* slightly prefers oak to holm oak; *Glomeris pulchra* shows no preference when it is given *Cistus* and *Pistacia*.

3. Discussion

When studying the transformation of the C/N ratio during the digestion of food, we must keep in mind that the modifications of this ratio are partly due to the state of conservation of the leaves, as is shown by some observations made by WITTICH (1943—1944) about C/N ratio for a number of species. More precisely, whereas I have found for chestnut leaves the following values of C/N: 31,44; 34,48; 29,82 (average 31,91), in leaves just fallen WITTICH has found a C/N ratio equal to 47,4. For the beech I have found a ratio as follows: 28,0; 30,5; 29,86 (average 29,45), whereas WITTICH has obtained 47; 58; 44; 56; (average 51) for leaves just fallen, 33 for leaves fallen since 11 months and 30 for leaves fallen since 23 months. For the oak I found 36; 32; 39,11 (average 37,71), and WITTICH 53 for leaves just fallen and 33 for leaves fallen since 23 months. For the holm oak I found 31,86; 32,10; 38,79 (average 34,25), whereas WITTICH in leaves just fallen obtained a value equal to 33,1. The differences between my data and those obtained by WITTICH can be attributed to the different state of conservation of leaves: indeed, WITTICH has obtained the highest values of C/N for just fallen leaves, whereas the ratio decreases with the ageing of leaves. Since I have carried out my determinations upon leaves collected in the field where the animals were caught, we can say nothing about their age.

As far as food preferences are concerned, the lack of any previous knowledge in the genus *Glomeris* makes impossible any discussion[5]).

The only diplopod in which food preferences have been studied in detail is the julid *Julus scandinavius*. Precisely, DUNGER (1962) finds the following order of preference: lime, ash, black alder, elm, maple, beech, oak and red beech. This succession corresponds to the speed with which the leaves are altered in natural conditions. The leaves which have hibernated (dead) are attacked more easily than those just fallen. *Cylindroiulus teutonicus*, investigated by STRIGANOVA (1967), prefers the leaves of oak (*Quercus robur*) to those of maple (*Acer pseudoplatanus*). According to KAESTNER (1963), Julidae and Polydesmidae eat only litter with a high water content, softened and with a low C/N ratio. When they are offered moistened leaves of different trees, they prefer those leaves that are degraded more easily and more rapidly. The preferential series established by this author for 8 species of leaves in autumn corresponds closely to a succession established on the ground of speed of leaf breakdown, and is modified after the winter.

It is worth while mentioning DÖLLING's (1962) researches on the breakdown of litter in the aquatic environment. "Hard" leaves, as those of beech or oak, are eaten only when other food is absent; furthermore, the soft parts of leaves are eaten before, and only when they are absent the harder parts (nervatures) are attacked. As a whole, the same seems to happen also in the breakdown of litter in terrestrial habitat; *Glomeris pulchra* would be

5) Basing on field observations, on Monte Grappa the leaves most sought by *Glomeris* seem to be chestnut, hazel, false acacia (*Robinia pseudoacacia*), bramble, beech, oak and very secondarily coniferous species (MARCUZZI and CELOTTO); on the Colli Euganei the leaves most sought by *Glomeris* seem to be chestnut, *Robinia*, hornbeam and bramble (MANZI). *Glomeris pulchra*, which is a species limited to mediterranean sclerophyllous forest or "maqui", feeds very probably on *Pistacia* (both *lentiscus* and *terebinthus*), *Quercus ilex* (holm oak), *Cistus* and secondarily on *Smilax aspera* and perhaps olive tree (not published observations). Recently HAACKER (1969) has studied the food habits of *Glomeris marginata* in Rhenania; the food taken by this animal is in percentage as follows: litter of deciduous trees 87; wood 2; grass 6; moss 6. The litter of coniferous trees is not consumed.

an exception, having the capacity to eat indifferently "hard" (*Pistacia*) or soft (*Cistus*) leaves.

According to DUNGER (1962) the alimentary spectrum varies very much as a consequence of the ecological characteristics of the species or the ecological characters of the locality from which the animals are coming. The degraders, and more precisely the secondary ones tolerate great variations of the C/N ratio; the primary ones are, on the contrary, more demanding.

From our experiments we can say that *Glomeris* show a rather large euryphagy, but further research is necessary to make this clearer.

Since BACHELIER (1963 pag. 250) says that *Glomeris* prefer leaves with a high amount of calcium, I investigated the relationship between the calcium content of the leaves and the food preference of the different species. For the values of calcium I have relied on WITTICH's data (1943).

As far as *Glomeris euganeorum* is concerned, the preference between holm oak (calcium = 25,96%) and chestnut (calcium = 30,57%) is for a species with a lower content of calcium, i. e. holm oak. The same holds when beech (calcium = 18,86%) is tested against holm oak (calcium = 26,17%). However, when we test oak-chestnut, oak-holm oak, beech-chestnut and beech-oak, the animals show no preference, though there is a strong difference in the calcium content of the different leaves. We can confirm therefore that calcium content of leaves influence very slightly the food preference of this species of *Glomeris*.

Glomeris undulata prefers oak to holm oak (which has a smaller amount of calcium), but when we test chestnut-holm oak and chestnut-beech there is no preference, so that even for this species we can think that calcium amount exerts no influence on its food preference.

4. Literature

BACHELIER, G., 1963. La vie animale dans les sols. Off. Rech. Sci. Techn. d'Outremer, Paris.

BOCOCK, K.L., 1963. The digestion and assimilation of food by *Glomeris*. In: DOEKSEN, J., and J. VAN DER DRIFT (eds.): Soil Organisms. Amsterdam.

DÖLLING, L., 1962. Der Anteil der Tierwelt an der Bildung von Unterwasserböden. Verh. Zool. Bot. Ges. Wien, **101/102**, 50.

DRIFT, J. VAN DER, 1951. Analysis of the animal community of a beech forest floor. Meded. Inst. Toegep. biol. onderz., Nat. **9**, 1.

DUNGER, M., 1962. Nahrungswahl bei Bodenarthropoden in produktionsbiologischer Sicht. Verh. XI. Intern. Kongr. Entom., Wien 1960, **3**, 169.

FRANZ, H., und L. LEITENBERGER, 1948. Biologisch-chemische Untersuchungen über Humusbildung durch Bodentiere. Öst. Zool. Z. **1**, 498.

GERE, G., 1956. The examination of the feeding biology and the humificative function of Diplopoda and Isopoda. Acta Biol. Hungar. **6**, 257.

HAACKER, U., 1968. Deskriptive, experimentelle und vergleichende Untersuchungen zur Autökologie rhein-mainischer Diplopoden. Oecologia (Berl.) **1**, 87.

KAESTNER, A., 1963. Lehrbuch der Speziellen Zoologie. **I**, 2, Stuttgart.

MANZI, G., 1959. Osservazioni ecologiche e faunistiche sui *Glomeris* (Myriapoda, Diplopoda) dei Colli Euganei. Atti Ist. Ven. Sc. Lett. Arti **117**, 241.

MARCUZZI, G., et A. CELOTTO, 1964. Appunti sull'ecologia dei *Glomeris* (Myriapoda, Diplopoda) del Veneto e della Venezia Tridentina. Atti Ist. Ven. Sc. Lett. Arti **122**, 21.

STRIGANOVA, B. R., 1967. Über die Zersetzung von überwinterter Laubstreu durch Tausendfüßler und Landasseln. Pedobiologia **7**, 125.

WITTICH, W., 1943. Untersuchungen über den Verlauf der Streuzersetzung auf einem Boden mit Mullzustand (II). Forstarch. **19**.

— 1944. Untersuchungen über die Streuzersetzung auf einem Boden mit Mullzustand (IV). Ibidem, **20**.

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